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ABSTRACT

A battery of seven psychomotor/perceptual tests was administered to two samples of Air Force personnel: officer trainees slated to attend undergraduate navigator training, and enlisted airmen in 30 different career fields. The objective was to determine the validity of the battery for the prediction of success in technical training courses. The battery consisted of seven tests designed to measure kinesthetic memory, percpetual speed, performance under stress, associative learning, memory (immediate and delayed), concept identification, and performance under divided attention. Test descriptions and tasks are included. Statistical data included intercorrelations among battery scores, training outcome criteria, and Air Force Officer Qualifying Test composites for the 120 officer trainees, as well as intercorrelations among battery scores, training outcome criteria and Armed Services Vocational Aptitude Battery composites for the 395 enlisted personnel subjects. The best single predictor of success in navigator training for officer trainees and of training disposition (pass/fail) for enlisted personnel was mean response time on the kinesthetic memory instrument. Analyses indicated that several of the psychomotor/perceptual measures were individually predictive of training outcomes; however, the joint contribution of the entire battery was, in general, not statistically significant. Further research is recommended. (Author/JAC)

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VALIDATION OF A PSYCHOMOTOR/PERCEPTUAL TEST BATTERY

By

David R. Hunter
Vincent A. Maurelli, Sgt, USAF
Nancy A. Thompson

PERSONNEL RESEARCH DIVISION
Lackland Air Force Base, Texas 78236

July 1977
Final Report for Period November 1974 – December 1976

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A battery of seven psychomotor/perceptual tests was administered to two samples of Air Force personnel: Officer Trainees slated to attend undergraduate navigator training (UNT) and Airmen in 30 different career fields.

The objective of the project was to determine the validity of the tests comprising the battery for the prediction of success in technical training courses.

Analyses of the data indicated that several of the psychomotor/perceptual measures were individually predictive of training outcomes; however, the joint contribution of all the tests in the battery was, in general, not

Item 20 (Continued)

statistically significant. The reasons for this result are discussed, and comparisons with the predictive validity of Air Force paper-and-pencil measures are made.

Recommendations for subsequent research and development are given.

PREFACE

This work was performed under project 7719, Selection and Classification Technology task 771915, Perceptual/Motor and Computer Managed Measurement.

The authors express their appreciation to Mr. Henry W. Clark of the Computational Sciences Division of AFHRL for his invaluable services in the analysis of the data, and to Airman Mary Meneilly and Sgt Louis Kaluza for their help in the gathering of the data.

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VALIDATION OF A PSYCHOMOTOR/PERCEPTUAL TEST BATTERY

I. INTRODUCTION

The present selection and classification instruments of the Air Force consist almost entirely of paper-and-pencil measures of the traditional cognitive abilities–verbal ability, mathematical reasoning, spatial perception, mechanical and general knowledge, etc. While these tests possess some validity for the selection of personnel for technical training, many of the tasks which comprise Air Force technical training courses involve some degree of psychomotor/perceptual skill which previous research (i.e., Hunter, 1975; McLaurin, 1973) has indicated is relatively untapped by conventional paper-and-pencil tests.

Furthermore, it is often argued that conventional paper-and-pencil testing may discriminate against those individuals from disadvantaged social or educational backgrounds. A previous study (Hunter, 1975), which used this psychomotor/perceptual battery of tests, indicated that while there were relatively consistent differences between conventionally defined high- and low-ability groups on psychomotor/perceptual measures, these differences were far less than the differences between the groups on traditional paper-and-pencil measures. Thus, the use of psychomotor/perceptual measures as predictors of technical training success might allow the assessment of relatively unique variance while at the same time avoiding one of the major criticisms of conventional testing.

This study was designed to address the first of these questions–how valid are these measures for the prediction of training outcomes? Although the battery was originally designed to be used with enlisted personnel, the characteristics and tasks of the tests contained in the battery also suggested a possible utility in the selection of personnel for navigator training. Therefore, two samples of Air Force personnel were tested–officer trainees selected for navigator training and enlisted personnel who attended a variety of technical training schools–and independent analyses of the data gathered from these two samples were performed.

II. TEST DESCRIPTIONS[1]

Psychomotor/Perceptual Battery

Test 1. Kinesthetic Memory–requires that the subject learn a sequence of switch manipulations and then repeat those manipulations while wearing opaque goggles. The subject is shown four geometric figures arranged in a horizontal line across the screen. The subject is instructed to pull down the toggle switch that is associated with each of the figures, in the order in which they appear on the screen (left to right). Before initiating the switch pulling and after completion of the response, the subject is required to keep two "home" keys pressed down. Release of one of these buttons, when the subject initiates his response, causes the screen to be erased so that he cannot use it for reference while performing the task. The subject receives 12 learning trials in which the order of the figures across the screen is always the same and in which a bell tone accompanies the onset of the stimulus. After completion of these learning trials, the subject is instructed to put on a pair of opaque goggles so that he is no longer able to see the response panel. After he has done so, he is told to repeat the switch activation sequence every time he hears the bell tone. Twelve trials are given in this condition. The measures obtained are (a) Correct Answers–the number of times he correctly completes the switch activation sequence while wearing the goggles, and (b) Response Time–which is the time required for the completion of each of the blind trials measured from release of one of the "home" buttons to completion of the activation sequence.

Test 2. Perceptual Speed–presents the subject with four geometric figures arrayed across the screen as in Test 1. However, in this test the ordering of the figures across the screen is quasi-random, so that no presentation is identical to the preceding one. The subject is given two practice trials followed by 20 scored trials. In addition to the Correct Answers and Response Time measures described for Test 1, a measure called Perception Time is also obtained. This is the length of time that the subject studies the display before initiating his response, measured from onset of the stimulus presentation to release of one of the "home" keys.

Test 3. Performance Under Stress–is very similar to Test 2, except that some of the figures in the stimulus are shaded. The subject is instructed to pull down the toggle switch associated with unshaded figures, as he did in Test 2, and to push up the toggle switch associated with shaded figures. To increase the subject's stress level, an audio tape recording of compressed tower-to-aircraft communications is played during the test. No responses to these messages are required of the subject, and he is instructed to

[1] Complete descriptions of the test procedures–including instructions to the subjects, computer operations, test administrator's actions, and listings of all stimuli used in each test–are contained in Appendix A of AFHRL-TR-75-60.

ignore them as much as he can. Two practice trials are given followed by 20 scored trials. The measures obtained are the same as in Test 2.

Test 4. Associative Learning—uses the keyboard located in the center of the panel. The subject is shown some of the figures on the keyboard paired with "stick figure" drawings of common objects (i.e., table, man, board) or novel geometric figures and is instructed to learn the pairings. Each pair of figures is shown to the subject three times. During Part 1 of this test, the pairs of figures are displayed for 2 seconds per presentation during the learning trials. After being given the learning trials, the subject is then shown each of the stimulus figures one at a time and is instructed to press the keyboard button figure that was paired with the figure on the screen. One recall trial is given for each of the eight stimulus figures used.

Part 2 of the test is identical to Part 1, except that the presentation time of the pairs of figures in the learning phase is changed to 1/2 second. Eight new stimulus figures are used and, as in Part 1, 24 learning trials are followed by eight recall trials. The measures obtained from both parts of this test are Correct Answers, which is the number of times the subject responds to the recall presentations with the correct keyboard figure.

Test 5. Memory (Immediate/Delayed)—involves both immediate- and short-term memory of symbols under continuously changing storage state. The immediate memory test consists of a continuous random series of presentations of one of the nine geometric keyboard figures. The subject is instructed to depress the appropriate keyboard button for the figure which appeared two figures back when the third figure appears on the display. Each time a new figure appears, the subject is to press the appropriate button for the figure which appeared two back. Each of the nine figures on the keyboard is presented three times, in a quasi-random order, requiring a total of 25 responses. In the immediate memory test (Part 1), the figures are displayed for a 2-second stimulus duration with a 2-second intersignal interval. Before the test begins, the subject is given five practice presentations requiring three responses.

The delayed memory portion of the test (Part 2) has an intersignal interval of 5 seconds. For both parts, the score (Correct Answers) is the number of correct responses.

Test 6. Concept Identification—requires that the subject identify the common element in a series of geometric figures. Both positive and negative instances of the concept (presence or absence of a right angle, or presence of four or five sides) are displayed an equal number of times. The concept to be used for any particular subject is determined by the computer choosing randomly from among the four concepts available.

The subject is initially informed that some of the figures he will see on the screen are alike in a certain way—that they have some property or feature in common. The subject is instructed to press the right-hand "home" key when the figure on the screen has the certain characteristic that makes it like the others, and to press the left-hand home key if the figure on the screen does not possess the certain property which makes it like the others. After pressing either button, the subject receives feedback regarding the correctness of his choice in the form of a check mark on the screen for a correct response and an "X" for an incorrect response. An "X" also occurs after 5 seconds if no response is made by the subject. The presentation of the next figure follows approximately 1 second after the display of the feedback information. No practice trials are given, and the subject receives 48 trials for score. The measure obtained (Correct Answers) is the number of times the subject correctly identifies the presence or absence of the selected property.

Test 7. Performance Under Divided Attention—involves the performance of two compensatory tracking tasks at the same time. Using the hand-controller located to the right of the response panel, the subject tries to keep a short horizontal line as close to the center of the screen as he can. The line is moved either up or down, away from the center by a forcing function. At the same time, the subject is required to use the hand-controller to the left of the response panel to track the null point between two tones (Morse "A" and "N"). The null point is moved by a second forcing function so that the subject must make continuous adjustments to stay at the null point.

Practice trials are given on the tasks (singly and together before the four 1-minute trials for score begin. The measures obtained are the summed absolute displacements of the two hand-controllers from the target points for each minute of the test. For the visual tracking task, these measurements would be in terms of addressable scope units (approximately .01 inch), and for the audio tracking task the unit of measurement is the digital analog of the hand-controller voltage.

III. SUBJECT TESTING

Sample A–Officer Trainees

Officer (navigator) trainees were tested while in attendance at the Air Force Officer Training School, Medina Annex, Lackland AFB, Texas. Approximately 120 trainees were tested over a 6-month period. Analyses were based upon a subset of 77 trainees for whom valid test scores and training criteria were available.

Sample B–Enlisted Personnel

Enlisted personnel were tested during or immediately after completion of basic military training at Lackland AFB, Texas. Approximately 500 subjects were tested over a 24-month period. Analyses were based upon a subset of 395 subjects for whom valid test scores and training outcome criteria were available. Distribution of the enlisted subjects by career field is given in Table 1.

IV. DATA ANALYSIS

Sample A–Officer Trainees

Means and standard deviations for the psychomotor/perceptual test scores were computed and are given in Table 2. Measures labeled "Correct Answers" are the number of correct responses obtained during each test. Measures labeled "Mean Response Time" or "Mean Perception Time" were formed by taking the arithmetic average of the perception or response times of all items in the test (excluding items to which the subject did not respond and, hence, had a perception or response time of zero). The incidence of the zero time scores for tests 1, 2, and 3 are also reported.

Means and standard deviations for the training outcome criterion and Air Force Officer Qualifying Test (AFOQT) composites were also computed and are given in Table 3.

Intercorrelations among psychomotor/perceptual scores, training criteria, and AFOQT composites are given in Table 5.

A regression problem comparing the relative contributions of AFOQT composites and psychomotor/perceptual test scores for the prediction of training outcome (pass/fail) was performed and is summarized in Table 6.

Corrections for "shrinkage" (using the formula given in Guilford and Fruchter, 1973, p. 366) were applied to the observed multiple correlations, and these corrected R^2s are also given in Table 6.

Sample B–Enlisted Personnel

Means and standard deviations for the psychomotor/perceptual test scores using the entire sample (N = 395) are given in Table 2. Means and standard deviations for the Armed Services Vocational Aptitude Battery (ASVAB) composites and training outcome criteria were computed for the entire sample and are given in Table 4.

Intercorrelations among the psychomotor/perceptual test scores, ASVAB composites, and training outcome criteria are given in Table 7.

In an effort to examine the validity of the tests for specific training areas, four subsamples were selected from the total sample. These subsamples were comprised of subjects in career fields 20 (N = 37), 43 (N = 122), 46 (N = 62), and 90 (N = 35).

The correlations of the psychomotor/perceptual test scores and ASVAB composites with the training criteria are given in Tables 8, 9, 10, and 11 for the respective career fields.

Table 12 summarizes regression problems performed to compare the relative contributions of psychomotor/perceptual tests and ASVAB composites for three training criteria for the total sample. Tables 13 and 14 summarize regression problems performed using the career fields 43 and 46 subsamples, respectively. Sufficient subjects were not available for meaningful comparisons within other career fields.

Corrected R^2s are also given in Tables 12, 13, and 14 for each regression problem.

V. RESULTS AND DISCUSSION

Sample A–Officer Trainees

As expected, several of the psychomotor/perceptual measures were found to be individually predictive of training outcomes for both the officer trainees and enlisted samples. For the officer trainees, the best single predictor of success/failure in navigator training was Test 1–Mean Response Time (A-8), with Test 7–Correct Answers (A-7) and Test 5–Correct Answers (Part 1) (A-17) being the second and third best single predictors.

Each of these predictors correlated over .20 with the pass/fail criterion, while the Quantitative Composite of the AFOQT correlated .15 with the criterion. None of the other AFOQT composites correlated over .08 with the criterion, including the Navigator composite which correlated only

Table 1. **Distribution of Enlisted Subjects by Career Field (N=395)**

Career Field	Eliminee	Graduate	Total
20 – Intelligence	15	22	37
23 – Audiovisual	2	6	8
25 – Weather	0	4	4
27 – Command Control Systems Operations	1	4	5
29 – Communications Operations	0	9	9
30 – Communications – Electronics Systems	3	14	17
32 – Avionics Systems	4	10	14
36 – Wire Communication Systems Maintenance	1	2	3
39 – Maintenance Analysis	0	1	1
42 – Airman Aircraft Systems Maintenance	0	4	4
43 – Aircraft Maintenance	1	121	122
44 – Missile Maintenance	1	8	9
46 – Munitions and Weapons Maintenance	6	56	62
51 – Computer Systems	0	2	2
53 – Metalworking	0	2	2
54 – Mechanical/Electrical	5	7	12
55 – Structural/Pavements	1	0	1
56 – Sanitation	0	1	1
57 – Fire Protection	0	1	1
60 – Transportation	1	6	7
63 – Fuel Services	0	3	3
64 – Supply	0	3	3
70 – Administrative	0	16	16
73 – Personnel	0	1	1
79 – Information	1	1	2
81 – Security Police	0	8	8
90 – Medical	4	31	35
91 – Medical	1	0	1
98 – Dental	0	2	2
99 – Other	0	3	3

Table 2. Means and Standard Deviations for Navigator and Enlisted Samples on Psychomotor/Perceptual Measures

Psychomotor/Perceptual Measures	Navigators (N = 77)		Enlisted (N = 395)	
	Mean	SD	Mean	SD
Test 1 – Correct Answers	13.36	6.83	10.76	7.86
Test 1 – Mean Response Time	218.89	44.79	255.18	128.32
Test 2 – Correct Answers	13.19	4.76	11.95	6.16
Test 2 – Mean Perception Time	166.77	27.07	196.20	52.75
Test 2 – Mean Response Time	156.31	27.43	193.46	114.82
Test 3 – Correct Answers	8.21	5.92	5.15	5.48
Test 3 – Mean Perception Time	226.72	46.89	258.19	93.78
Test 3 – Mean Response Time	237.43	56.72	289.40	168.99
Test 4 – Correct Answers (Pt. 1)	4.64	1.98	3.25	2.04
Test 4 – Correct Answers (Pt. 2)	2.17	1.28	1.81	1.11
Test 5 – Correct Answers (Pt. 1)	15.21	5.92	12.33	5.72
Test 5 – Correct Answers (Pt. 2)	19.19	6.52	15.77	7.43
Test 6 – Correct Answers	32.68	6.32	28.85	8.07
Test 7 – Line Error, Min. 1	4956.	1154.	5988.	2720.
Test 7 – Line Error, Min. 2	4965.	1201.	6076.	2724.
Test 7 – Line Error, Min. 3	5121.	1379.	5985.	2573.
Test 7 – Line Error, Min. 4	4840.	1354.	5856.	2520.
Test 7 – Tone Error, Min. 1	2165.	667.	2420.	951.
Test 7 – Tone Error, Min. 2	2135.	789.	2433.	948.
Test 7 – Tone Error, Min. 3	2000.	759.	2414.	1001.
Test 7 – Tone Error, Min. 4	1902.	731.	2371.	936.
Test 1 – No Responses	7.16	6.34	7.32	5.86
Test 2 – No Responses (Percep)	1.25	1.80	1.20	3.01
Test 2 – No Responses (Motor)	1.62	2.16	1.41	3.13
Test 3 – No Responses (Percep)	.91	1.37	1.77	2.29
Test 3 – No Responses (Motor)	.94	1.43	2.10	2.77
Total No Responses	11.87	8.55	13.80	11.40

Table 3. Means and Standard Deviations for Navigator Sample on Criterion and Paper-and-Pencil Measures (N = 77)

Sample	Mean	SD
Training Disposition (Grad. = 1)	.83	.37
AFOQT – Pilot	29.77	37.19
AFOQT – Navigator	41.81	37.82
AFOQT – Officer Quality	39.04	36.73
AFOQT – Verbal	28.91	30.36
AFOQT – Quantitative	28.71	30.22

Table 4. Means and Standard Deviations for Enlisted Sample on Criterion and Paper-and-Pencil Measures (N = 395)

Sample	Mean	SD
Training Disposition (Grad. = 1)	88	.32
Final ATC Standard Score	82.67	11.14
Number of Academic Washbacks	.19	.56
ASVAB – Administrative	55.67	19.68
ASVAB – Electronics	68.08	17.48
ASVAB – General	68.11	17.72
ASVAB – Mechanical	64.75	19.35

Table 5. Intercorrelation Matrix for Navigator Sample

Variable	A-1	A-2	A-3	A-4	A-5	A-6	A-7	A-8	A-9	A-10	A-11	A-12	A-13	A-14	A-15	A-16	A-17	A-18	A-19	A-20	A-21	A-22	A-23	A-24	A-25	A-26	A-27	A-28	A-29	A-30	A-31	A-32
A-1 Training Disposition																																
A-2 AFOQT – Pilot	.06																															
A-3 AFOQT – Navigator	.08	.91																														
A-4 AFOQT – Officer Quality	.07	.83	.87																													
A-5 AFOQT – Verbal	.03	.76	.75	.85																												
A-6 AFOQT – Quantitative	.12	.71	.78	.85	.62																											
A-7 Test 1 – Correct Answers	.24	.02	.06	.11	.13	.21																										
A-8 Test 1 – Response Time	-.32	.07	.11	.07	.06	.09	-.34																									
A-9 Test 2 – Correct Answers	.05	.23	.17	.18	.17	.15	.08	.07																								
A-10 Test 2 – Perception Time	-.16	.12	.16	.12	.16	.02	-.33	.59	-.01																							
A-11 Test 2 – Response Time	-.17	.19	.21	.15	.26	.05	-.31	.52	.06	.80																						
A-12 Test 3 – Correct Answers	.13	-.16	-.05	-.02	-.09	-.01	.29	-.11	.28	-.19	-.25																					
A-13 Test 3 – Perception Time	.05	.17	.19	.23	.26	.21	-.09	.35	.01	.44	.40	.02																				
A-14 Test 3 – Response Time	.01	.05	.08	.09	.21	.09	-.09	.38	-.07	.32	.29	-.07	.72																			
A-15 Test 4 – Correct Answers (Pt. 2)	.07	.04	.03	.09	.04	.03	.40	-.45	.07	-.25	-.25	.17	-.28	-.36																		
A-16 Test 4 – Correct Answers (Pt. 2)	.11	.02	.08	.17	.09	.02	.35	-.05	.01	.02	-.03	.15	-.31	-.01	.16																	
A-17 Test 5 – Correct Answers (Pt. 1)	.23	.20	.15	.08	.13	.05	.27	-.39	.06	-.32	-.25	.17	-.37	-.44	.39	.18																
A-18 Test 5 – Correct Answers (Pt. 2)	.14	.24	.19	.17	.19	.13	.11	-.35	.05	-.32	-.36	.22	-.44	-.51	.33	.23	.65															
A-19 Test 6 – Correct Answers	.11	.08	.03	.17	.15	.14	.11	-.09	.30	-.13	-.17	.18	.18	.11	.20	.04	.15	-.00														
A-20 Test 7 – Line Error, Min. 1	-.03	.22	.23	.23	.30	.18	.07	-.05	.12	.05	.17	-.18	.09	.06	-.04	.18	-.03	-.10	.00													
A-21 Test 7 – Line Error, Min. 2	.22	.08	.10	.08	.07	.07	.03	.08	.21	.14	.10	.08	.09	.15	-.11	-.10	-.08	-.02	.11	.55												
A-22 Test 7 – Line Error, Min. 3	.08	.08	.11	.09	.11	.12	.11	-.02	-.09	.21	.21	-.08	.09	.09	-.06	-.10	-.05	-.01	-.00	.60	.59											
A-23 Test 7 – Line Error, Min. 4	.08	.01	.08	.08	.12	.05	-.01	.07	.02	.13	.10	.02	.01	.14	-.13	-.04	-.05	.01	.07	.59	.63	.72										
A-24 Test 7 – Tone Error, Min. 1	.07	.19	.11	.13	.21	.08	-.10	.27	.09	.32	.25	-.16	.25	.31	-.05	-.13	-.27	-.28	-.02	.05	-.04	-.09	-.09									
A-25 Test 7 – Tone Error, Min. 2	-.01	.13	.13	.16	.25	.11	.15	.36	.14	.34	.33	-.22	.39	.46	-.13	-.09	-.16	-.27	-.09	.17	.12	-.01	.07	.69								
A-26 Test 7 – Tone Error, Min. 3	-.06	.09	.04	.08	.17	-.04	-.06	.25	.10	.16	.16	-.16	.20	.31	-.06	-.06	-.13	-.22	-.04	.19	.16	.09	.09	.66	.71						
A-27 Test 7 – Tone Error, Min. 4	.03	-.00	.05	-.02	.04	-.06	-.06	.26	.09	.24	.22	-.15	.06	.09	.05	-.08	-.22	-.15	-.06	.17	.08	.07	.07	.62	.46	.65						
A-28 Test 1 – No Responses	-.21	-.08	-.13	-.19	-.17	-.21	-.88	.34	-.19	.39	.33	-.25	.22	.23	-.41	-.30	-.27	-.15	-.06	-.11	-.05	-.06	.05	.17	.18	.05	.07				
A-29 Test 2 – No Responses (Perception)	.08	-.05	.03	-.05	-.10	.01	.04	.03	-.71	.14	-.06	.15	.02	.02	-.08	.15	-.08	-.01	-.16	-.15	-.10	.15	-.05	-.05	-.10	-.18	-.22	.09			
A-30 Test 2 – No Responses (Response)	-.09	-.20	-.16	-.17	-.17	-.18	-.10	.08	-.71	.08	.07	-.08	.24	.12	-.07	.03	-.10	-.14	-.18	-.13	-.21	.01	-.12	-.13	-.12	-.09	-.13	.21	.64		
A-31 Test 3 – No Responses (Perception)	.07	.10	.14	.07	.01	.08	.04	.15	-.42	.09	-.05	-.13	.26	.12	-.12	.11	-.10	-.21	-.00	-.10	-.18	-.08	-.03	.06	-.02	.03	-.01	.07	.53	.49	
A-32 Test 3 – No Responses (Response)	.05	.01	.02	.10	.27	.05	.22	.02	-.26	.08	.11	-.18	.30	.35	-.08	.06	-.04	-.24	.01	.11	-.12	-.02	.05	.13	.18	.15	.05	-.13	.14	.15	.55
A-33 Total No Responses	.14	.14	.16	.19	.14	.21	.62	.31	-.57	.36	.26	-.29	.34	.29	-.37	.15	-.27	-.22	-.12	-.14	-.16	-.03	-.00	.11	.11	.01	-.02	.80	.55	.65	.54	.22

Table 6. **Regression Problems for Navigators (N = 77)**

Model	Predictors	No. of Predictors	R^2	F	c^{R^2}
Full	AFOQT and Psychomotor	31	.447		.09
Restricted[c]	Psychomotor	26	.420	0.44[a]	.14
Restricted[d]	AFOQT	5	.036	1.29[a]	.02

[a]Not Significant.
[b]R^2 corrected for shrinkage.
[c]Null Hypothesis: AFOQT makes no contribution to Psychomotor.
[d]Null Hypothesis: Psychomotor makes no contribution to AFOQT.

Table 7. **Intercorrelation Matrix for Enlisted Sample**

Variables	B-1	B-2	B-3	B-4	B-5	B-6	B-7	B-8	B-9	B-10	B-11	B-12	B-13	B-14	B-15	B-16	B-17	B-18	B-19	B-20	B-21	B-22	B-23	B-24	B-25	B-26	B-27	B-28	B-29	B-30	B-31	B-32	B-33
B-1 Training Disposition																																	
B-2 Final ATC Standard Score	.70																																
B-3 Number of Academic Washbacks	−.19	−.27																															
B-4 ASVAB – Administrative	.09	.17	−.04																														
B-5 ASVAB – Electronics	.04	.19	−.16	.30																													
B-6 ASVAB – General	.08	.17	−.14	.51	.59																												
B-7 ASVAB – Mechanical	.14	.30	−.19	.07	.55	.31																											
B-8 Test 1 – Correct Answers	−.08	.01	.08	.24	.13	.13	.06																										
B-9 Test 1 – Response Time	−.22	−.21	.04	−.10	−.05	−.09	−.04	.07																									
B-10 Test 2 – Correct Answers	−.19	−.13	.11	.13	.08	.12	.01	.55	.07																								
B-11 Test 2 – Perception Time	−.10	−.16	.09	−.20	−.17	−.06	−.09	−.14	.19	.11																							
B-12 Test 2 – Response Time	−.13	−.13	.15	−.16	−.21	−.07	−.02	−.07	.09	.09	.46																						
B-13 Test 3 – Correct Answers	−.06	.02	.01	.22	.09	.09	.05	.36	−.04	.31	−.25	−.13																					
B-14 Test 3 – Perception Time	−.05	−.07	.01	−.07	.02	.00	−.07	−.03	.12	−.00	.41	.15	−.13																				
B-15 Test 3 – Response Time	−.09	−.15	−.02	−.04	−.03	.00	−.08	−.05	.09	−.02	.27	.12	−.09	.45																			
B-16 Test 4 – Correct Answers (Pt. 1)	.05	.11	−.08	.13	.25	.20	.22	.14	.01	.11	.16	−.07	.21	−.14	−.09																		
B-17 Test 4 – Correct Answers (Pt. 2)	.01	.05	.02	.08	.16	.05	.11	.09	−.01	.10	−.07	.05	.13	−.10	−.07	.25																	
B-18 Test 5 – Correct Answers (Pt. 1)	.08	.17	−.10	.24	.23	.14	.11	.33	−.11	.19	−.31	−.15	.29	−.19	−.15	.16	.24																
B-19 Test 5 – Correct Answers (Pt. 2)	.05	.15	−.12	.19	.24	.12	.13	.26	−.09	.12	−.34	−.17	.31	−.24	−.20	.19	.15	.70															
B-20 Test 6 – Correct Answers	−.00	.07	−.03	.12	.25	.13	.27	.15	−.00	.07	−.17	−.09	.17	−.06	−.09	.17	.07	.11	.12														
B-21 Test 7 – Line Error Min. 1	−.05	−.04	.03	−.12	−.06	−.05	−.04	−.06	.02	−.05	.03	.13	−.05	−.01	−.01	−.02	−.05	−.06	−.02	−.09													
B-22 Test 7 – Line Error, Min. 2	−.02	.00	.04	−.13	−.03	−.04	.01	−.05	.02	−.03	.03	.09	−.05	−.06	−.04	−.01	−.06	−.07	.00	−.09	.87											
B-23 Test 7 – Line Error, Min. 3	−.01	.01	.04	−.16	−.04	−.04	.04	−.01	.03	.02	.05	.10	−.03	−.04	−.05	−.03	−.08	−.05	−.02	−.06	.81	.84										
B-24 Test 7 – Line Error, Min. 4	−.02	−.03	.08	−.14	−.07	−.08	.04	.02	.03	.07	.04	.11	−.02	.07	−.06	−.06	−.08	−.11	−.04	−.04	.71	.75	.79									
B-25 Test 7 – Tone Error, Min. 1	−.00	−.08	.03	−.11	−.11	−.08	−.18	−.22	.04	−.15	.10	.04	−.08	−.02	.01	−.09	−.10	−.10	−.17	−.18	.17	.13	.16	.10								
B-26 Test 7 – Tone Error, Min. 2	−.01	−.06	.03	−.09	−.10	−.10	−.26	−.28	.03	−.19	.11	.08	−.08	−.01	.05	−.14	−.09	−.12	−.17	−.19	.16	.14	.14	.09	.71							
B-27 Test 7 – Tone Error, Min. 3	.02	−.04	−.02	−.05	−.14	−.03	−.17	−.26	.04	−.20	.13	.07	−.08	.02	.06	−.16	−.13	−.12	−.18	−.20	.17	.13	.13	.07	.70	.70						
B-28 Test 7 – Tone Error, Min. 4	−.03	−.06	.06	−.05	−.20	−.07	−.25	−.22	.00	−.17	.12	.08	−.06	−.03	.03	−.11	−.11	−.09	−.14	−.22	.24	.22	.18	.14	.65	.72	.73					
B-29 Test 1 – No Responses	−.00	−.08	.04	−.20	−.09	−.06	−.04	−.64	.08	−.18	.27	.17	−.22	.08	.08	−.19	−.10	−.30	−.25	−.13	−.04	−.04	−.05	−.06	.06	.09	.07	.07				
B-30 Test 2 – No Responses (Perception)	.10	.06	−.08	−.02	−.04	−.07	−.03	−.15	−.11	−.44	−.32	−.15	−.01	.02	.06	−.23	−.10	−.03	−.03	−.01	−.04	−.04	−.07	−.10	−.01	.08	.07	.01	.15			
B-31 Test 2 – No Responses (Response)	.12	.08	−.07	−.00	−.07	−.08	−.07	−.14	−.12	−.45	−.35	−.17	−.02	.01	.01	−.23	−.09	−.04	−.03	.03	−.06	−.06	−.09	−.12	−.06	.04	.02	−.01	.15	.03		
B-32 Test 3 – No Responses (Perception)	.10	.08	−.08	−.09	−.06	−.10	−.03	−.31	−.01	−.53	.18	.05	−.40	.22	.11	−.21	−.14	−.21	−.20	−.09	−.02	−.05	−.07	−.10	.06	.12	.15	.08	.17	.20	.24	
B-33 Test 3 – No Responses (Response)	.13	.09	−.10	−.09	−.06	−.10	.02	−.44	−.03	−.57	.18	.08	−.35	.15	.12	−.21	.15	−.16	−.17	−.08	.00	−.03	−.02	−.09	.10	.16	.16	.15	.26	.19	.23	.75	
B-34 Total No Responses	.11	.03	−.10	−.15	−.10	−.12	−.05	−.58	−.12	−.58	.04	.03	−.29	.13	.11	−.31	−.17	−.25	−.23	−.10	−.05	−.07	−.09	−.13	.05	.14	.13	.09	.69	.68	.69	.59	.64

Table 8. **Zero-Order Validities for Enlisted Subjects in Career Field 20-Intelligence (N = 37)**

Variable	Pass/ Fail	ATC Final Score	Wash-back*	Variable	Pass/ Fail	ATC Final Score	Wash-back*
ASVAB–Administrative	–.10	.01	.00	Test 6–Correct Answers	–.16	–.01	.00
ASVAB–Electronics	.11	.18	.00	Test 7–Line Error Min. 1	–.13	–.14	.00
ASVAB–General	.09	–.01	.00	Test 7–Line Error, Min. 2	–.14	–.13	.00
ASVAB–Mechanical	.00	.03	.00	Test 7–Line Error, Min. 3	–.06	–.06	.00
Test 1–Correct Answers	.06	.15	.00	Test 7–Line Error, Min. 4	–.22	–.19	.00
Test 1–Response Time	.02	–.12	.00	Test 7–Tone Error, Min. 1	.16	.20	.00
Test 2–Correct Answers	.04	.08	.00	Test 7–Tone Error, Min. 2	.08	.03	.00
Test 2–Perception Time	–.17	–.30	.00	Test 7–Tone Error, Min. 3	.07	.03	.00
Test 2–Response Time	–.28	–.34**	.00	Test 7–Tone Error, Min. 4	–.07	–.10	.00
Test 3–Correct Answers	.03	.11	.00	Test 1–No Responses	–.27	–.28	.00
Test 3–Perception Time	.00	–.13	.00	Test 2–No Responses (Perception)	–.07	–.15	.00
Test 3–Response Time	.08	–.02	.00	Test 2–No Responses (Response)	–.13	–.11	.00
Test 4–Correct Answers (Pt. 1)	.25	.29	.00	Test 3–No Responses (Perception)	.09	–.01	.00
Test 4–Correct Answers (Pt. 2)	.31	.38**	.00	Test 3–No Responses (Response)	–.16	–.13	.00
Test 5–Correct Answers (Pt. 1)	.28	.44**	.00	Total No Responses	–.27	–.30	.00
Test 5–Correct Answers (Pt. 2)	.22	.30	.00				

*No academic washbacks occurred in this group.
**(r_{crit} = .325, for $p < .05$)

Table 9. **Zero-Order Validities for Enlisted Subjects in Career Field 43-Aircraft Maintenance (N = 122)**

Variable	Pass/ Fail	ATC Final Score	Wash-back	Variable	Pass/ Fail	ATC Final Score	Wash-back
ASVAB--Administrative	.04	.12	−.01	Test 6–Correct Answers	.05	.14	.00
ASVAB–Electronics	.11	.47[a]	−.32[a]	Test 7–Line Error, Min. 1	−.03	.02	−.05
ASVAB–General	.06	.39[a]	−.05	Test 7–Line Error, Min. 2	−.12	.00	.04
ASVAB–Mechanical	.10	.37[a]	−.23[a]	Test 7–Line Error, Min. 3	−.05	.06	.01
Test 1–Correct Answers	.01	.09	.05	Test 7–Line Error, Min. 4	−.11	−.02	.04
Test 1–Response Time	−.08	−.22[a]	.07	Test 7–Tone Error, Min. 1	−.08	−.17	.07
Test 2–Correct Answers	−.09	−.02	.09	Test 7–Tone Error, Min. 2	.00	−.09	.08
Test 2–Perception Time	−.08	−.25[a]	.12	Test 7–Tone Error, Min. 3	−.21[a]	−.12	.15
Test 2–Response Time	−.04	−.16	.05	Test 7–Tone Error, Min. 4	−.04	−.11	.11
Test 3–Correct Answers	.08	.21[a]	.02	Test 1–No Responses	.04	−.17	−.08
Test 3–Perception Time	−.06	−.05	−.04	Test 2–No Responses (Perception)	.04	.03	−.08
Test 3–Response Time	−.04	−.14	−.06	Test 2–No Responses (Response)	.05	.01	−.10
Test 4–Correct Answers (Pt. 1)	.13	.24[a]	−.23[a]	Test 3–No Responses (Perception)	.02	.00	−.05
Test 4–Correct Answers (Pt. 2)	−.12	.03	.04	Test 3–No Responses (Response)	.09	−.01	−.16
Test 5–Correct Answers (Pt. 1)	.13	.22[a]	−.13	Total No Responses	.07	−.06	−.14
Test 5–Correct Answers (Pt. 2)	.18[a]	.30[a]	−.15				

[a](r_{crit} = .174 for $p < .05$).

Table 19. **Zero-Order Validities for Enlisted Subjects in Career Field 46-Munitions and Weapons Maintenance (N = 62)**

Variable	Pass/ Fail	ATC Final Score	Wash-back	Variable	Pass/ Fail	ATC Final Score	Wash-back
ASVAB--Administrative	.19	.31[a]	--.09	Test 6–Correct Answers	.09	.13	–.10
ASVAB–Electronics	.04	.20	–.11	Test 7–Line Error, Min. 1	.00	–.09	.24
ASVAB–General	.01	.14	–.02	Test 7–Line Error, Min. 2	.10	.02	.11
ASVAB–Mechanical	.28[a]	.42[a]	–.23	Test 7–Line Error, Min. 3	.05	–.05	.12
Test 1–Correct Answers	–.09	–.01	–.04	Test 7–Line Error, Min. 4	–.02	–.09	.14
Test 1–Response Time	–.39[a]	–.36[a]	.34[a]	Test 7–Tone Error, Min. 1	–.10	–.14	.18
Test 2–Correct Answers	–.13	–.10	.06	Test 7–Tone Error, Min. 2	–.01	–.06	.20
Test 2–Perception Time	–.03	–.03	.35[a]	Test 7–Tone Error, Min. 3	.11	.07	.04
Test 2–Response Time	.05	.01	.46[a]	Test 7–Tone Error, Min. 4	–.12	–.17	.23
Test 3–Correct Answers	.00	.11	.04	Test 1–No Responses	–.03	–.12	.09
Test 3–Perception Time	.10	.04	.07	Test 2–No Responses (Perception)	.09	–.01	.03
Test 3–Response Time	.13	.08	.31[a]	Test 2–No Responses (Response)	.07	–.03	–.05
Test 4–Correct Answers (Pt. 1)	–.08	–.03	–.10	Test 3–No Responses (Perception)	.11	.03	.07
Test 4–Correct Answers (Pt. 2)	–.01	.10	.05	Test 3–No Responses (Response)	.13	.03	.13
Test 5–Correct Answers (Pt. 1)	.01	.05	.04	Total No Responses	.07	–.06	.08
Test 5–Correct Answers (Pt. 2)	.01	.01	–.12				

[a] $r_{crit} = .250$, for $p < .05$.

Table 11. Zero-Order Validities for Enlisted Subjects in Career Field 90-Medical (N = 35)

Variable	Pass/ Fail	ATC Final Score	Wash-back	Variable	Pass/ Fail	ATC Final Score	Wash-back
ASVAB–Administrative	.17	.28	.22	Test 6–Correct Answers	.07	.01	–.16
ASVAB–Electronics	.28	.42[a]	–.15	Test 7–Line Error, Min. 1	–.13	–.13	–.16
ASVAB–General	.39[a]	.54[a]	.13	Test 7–Line Error, Min. 2	–.01	.03	–.13
ASVAB–Mechanical	.17	.44[a]	–.07	Test 7–Line Error, Min. 3	–.10	–.10	–.11
Test 1–Correct Answers	.10	.21	.28	Test 7–Line Error, Min. 4	–.09	–.05	–.11
Test 1–Response Time	–.15	–.09	–.09	Test 7–Tone Error, Min. 1	–.09	–.06	.11
Test 2–Correct Answers	–.31	–.03	.13	Test 7–Tone Error, Min. 2	–.09	.01	–.04
Test 2–Perception Time	–.15	–.11	.12	Test 7–Tone Error, Min. 3	–.01	.03	.02
Test 2–Response Time	–.01	.13	.03	Test 7–Tone Error, Min. 4	–.05	.05	.27
Test 3–Correct Answers	–.21	–.06	–.08	Test 1–No Responses	.03	–.08	–.20
Test 3–Perception Time	.02	–.08	.05	Test 2–No Responses (Perception)	.13	–.11	–.06
Test 3–Response Time	.09	–.23	–.01	Test 2–No Responses (Response)	.13	–.06	–.06
Test 4–Correct Answers (Pt. 1)	.31	.43[a]	–.21	Test 3–No Responses (Perception)	.18	.02	.01
Test 4–Correct Answers (Pt. 2)	.25	.31	.01	Test 3–No Responses (Response)	.13	–.02	–.02
Test 5–Correct Answers (Pt. 1)	–.04	.19	.23	Total No Responses	.17	–.11	–.16
Test 5–Correct Answers (Pt. 2)	–.01	.10	.01				

[a] $r_{crit} = .325$, for $p < .05$.

Table 12. **Regression Problems for Total Enlisted Sample (N = 395)**

Criterion	Model	Predictors	No. of Predictors	R^2	F	$_cR^2$
Training Disposition						
	Full	ASVAB and Psychomotor	30	.158		.09
	Restricted[a]	Psychomotor	26	.128	2.57*	.07
	Restricted[b]	ASVAB	4	.034	2.06**	.03
Final ATC Standard Score						
	Full	ASVAB and Psychomotor	30	.215		.15
	Restricted[a]	Psychomotor	26	.142	6.72**	.08
	Restricted[b]	ASVAB	4	.111	1.85*	.10
Number of Academic Washbacks						
	Full	ASVAB and Psychomotor	30	.115		.04
	Restricted[a]	Psychomotor	26	.083	2.63*	.02
	Restricted[b]	ASVAB	4	.046	1.09[c]	.04

[a]Null Hypothesis: ASVAB makes no contribution to Psychomotor.
[b]Null Hypothesis: Psychomotor makes no contribution to ASVAB.
[c]Not Significant.
*$p < .05$.
**$p < .01$.

Table 13. **Regression Problems for Enlisted Sample in Career Field 43-Aircraft Maintenance (N = 122)**

Criterion	Model	Predictors	No. of Predictors	R^2	F	$_cR^2$
Final ATC Standard Score						
	Full	ASVAB and Psychomotor	30	.377		.18
	Restricted[a]	Psychomotor	26	.277	3.61*	.09
	Restricted[b]	ASVAB	4	.266	.62[c]	.25
Number of Academic Washbacks						
	Full	ASVAB and Psychomotor	30	.314		.10
	Restri	Psychomotor	26	.222	3.02**	.02
	Restrict	ASVAB	4	.123	.97[c]	.10

[a]Null Hypothesis: ASVAB makes no contribution to Psychomotor.
[b]Null Hypothesis: Psychomotor makes no contribution to ASVAB.
[c]Not Significant.
*$p < .01$.
**$p < .05$.

Table 14. **Regression Problems for Enlisted Sample in Career Field 46-Munitions and Weapons Maintenance (N = 62)**

Criterion	Model	Predictors	No. of Predictors	R^2	F	$_cR^2$
Final AFQT Standard Score						
	Full	ASVAB and Psychomotor	30	.610		.26
	Restricted[a]	Psychomotor	26	.395	4.13*	.03
	Restricted[b]	ASVAB	4	.214	1.21[c]	.17
Number of Academic Washbacks						
	Full	ASVAB and Psychomotor	30	.607		.25
	Restricted[a]	Psychomotor	26	.599	0.15[c]	.32
	Restricted[b]	ASVAB	4	.063	1.65[c]	.01

[a]Null Hypothesis: ASVAB makes no contribution to Psychomotor.
[b]Null Hypothesis: Psychomotor makes no contribution to ASVAB.
[c]Not Significant.
*$p < .01$.

.08. These correlations are somewhat attenuated due to restriction in the range caused by selection of the personnel in the sample based upon the Navigator composite, and also because the correlations for the AFOQT composites were based upon percentiles–the original raw scores not being available.

In the regression problem comparing the contributions of AFOQT and psychomotor/perceptual scores for the prediction of pass/fail in undergraduate navigator training (UNT), both sets of predictors failed to achieve statistical significance in their individual contributions to prediction. This may be accounted for in part by the small sample size in relation to the number of predictor variables used. However, the corrected multiple correlations ($_cR^2$), which are unbiased estimates of the true correlations in the population, would suggest that the AFOQT is less predictive of UNT success than are the psychomotor/perceptual measures.

Sample B–Enlisted Personnel

For the enlisted sample, correlations of the predictor measures with three training criteria were obtained. These training criteria were (a) Training Disposition–Pass/Fail (Var. B-1), (b) Final Air Training Command (ATC) Standard Score (Var. B-2), and (c) Number of Academic Washbacks (Var. B-3). These three training criteria were chosen for evaluation because, while individually they each have shortcomings as an overall training criterion, collectively they describe rather well the outcomes of interest in a training situation. Specifically, while the Training Disposition–Pass/Fail variable imposes an artificial dichotomy upon the score distribution which reduces its variance and hence its psychometric properties as a training criterion, it is probably a measure of special interest to the organization performing the training which evaluates its training effectiveness partly in terms of the loss rate during training. The Final ATC Standard Score gives a better distribution of scores among students since it is a continuous measure and hence allows for better evaluation of the predictors for distinguishing between different levels of success in training. The Number of Academic Washbacks was included because often students will be set back due to failure to meet some performance objectives for a specified block of training and will subsequently graduate with ATC Standard Scores similar to other students who were able to complete the training course without repeating blocks. The number of these washbacks is therefore interesting if one wishes to cut down on the number of students who cannot progress through the course at the prescribed rate.

In the total sample (N = 395), the best single predictor of Training Disposition (B-1) was Test 1–Mean Response Time (B-9) with a correlation of –.22. The second and third best single predictors were Test 2–Correct Answers (B-10) and ASVAB Mechanical composite (B-7), with correlations of –.19 and .14, respectively. Error measures were used in several tests, resulting in negative correlations between the measures and the training outcome criteria. In all cases, the sign of the correlation coefficient may be ignored and only the absolute value considered.

For the ATC Standard Score (B-2), the best single predictor was ASVAB Mechanical Composite (B-7) with a correlation of .30, while the second and third best predictors were Test 1–Mean Response Time (B-9) and ASVAB Electronics composite (B-5) with correlations of –.21 and .19, respectively.

The best three predictors of the Number of Training Washbacks (B-3) were the ASVAB Mechanical (B-7) and Electronics (B-5) composites and Test 2–Mean Response Time (B-12) with correlations of –.19, –.16, and .15, respectively.

In the regression problems which used the total enlisted sample (N = 395), results were attenuated by the heterogeneity of the sample which included subjects from many Air Force career fields. This heterogeneity of training programs, coupled with the grouping together of subjects who had been preselected on the basis of widely divergent Aptitude Indexes, may have contributed to the relatively low correlations obtained.

It was found that for the prediction of Training Disposition (Pass/Fail), both the ASVAB and psychomotor/perceptual measures made statistically significant contributions. The same situation was found in the prediction of Final ATC Standard Score. In the prediction of Academic Washbacks, however, the psychomotor/perceptual measures did not make a significant contribution. In all these cases, the amount of variance accounted for by the predictors, as indicated by the corrected multiple correlations, was quite small.

In the prediction of both Final ATC Standard Score and Number of Academic Washbacks for subjects in career field 43–Aircraft Maintenance, psychomotor/perceptual failed to make a significant contribution, and, as in the total sample, the amount of variance accounted for by either set of predictors was small.

For subjects in career field 46–Munitions Maintenance, psychomotor/perceptual measures again failed to make statistically significant

contribution to the prediction of either criterion; however, for Academic Washbacks, the amount of variance accounted for was considerably greater than that attributable to the ASVAB.

The lack of more definitive results either in favor of or against the psychomotor/perceptual measures may be attributed, as was noted earlier, to the disproportionate number of predictor measures relative to the number of subjects. In an exploratory study of this type, many predictors are evaluated in an attempt to identify some smaller set that may have future promise When coupled with small sample size, this necessarily results in fewer statistically significant findings.

Future studies which exclude those psychomotor/perceptual measures that were found to be of little predictive validity in this study should result in less equivocal findings. This is evidenced through the zero-order validities reported for both the overall enlisted sample and the four subsamples in which certain of the psychomotor/perceptual measures yielded significant correlations with the criteria.

VI. CONCLUSIONS AND RECOMMENDATIONS

While definitive conclusions are not possible due to the limited scope of this study, it would appear that several of the psychomotor/perceptual measures offer promise for the improved selection of Air Force personnel. In particular, the psychomotor/perceptual measures seem to be superior to the AFOQT composites for the selection of personnel for navigator training. Considering the costly nature of navigator training, improvement through use of these techniques could have a significant dollar cost savings impact.

Despite the limitations of small sample sizes and heterogeneity of training programs encountered in this study, it would appear that some of the psychomotor/perceptual measures may be of utility in the selection of enlisted personnel for technical training. While the joint contribution of the entire battery often failed to achieve statistical significance, the zero-order validities of individual psychomotor/perceptual measures were often higher than those of the paper-and-pencil measures.

Additional research is recommended to further evaluate those measures from the psychomotor/perceptual battery which demonstrated appreciable validity in this study. Through the use of large homogeneous samples of both officer and enlisted personnel, the true utility of these measures may be accurately assessed. Since these tests are in general unique, they may make significant contributions to the optimal selection and assignment of Air Force personnel.

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